N00639.AR.002112
NSA MID SOUTH
5090.3a

LETTER TRANSMITTING U S GEOLOGICAL SURVEY INVESTIGATING IF NATURAL BIODEGRATION PROCESS IS SUFFICIENT TO REMEDIATE GASOLINE CONTAMINATION AT NAVY EXCHANGE SERVICE STATION MILLINGTON SUPPACT TN
6/2/1992
NSA MID SOUTH

5090
Code 1846
02 JUN 1992

Mr. Mike Langreck
Division of Ground Water Protection
Tennessee Department of Environment & Conservation
150 9th Avenue North
Nashville, TN 37219-5405

PETROLEUM CONTAMINATION AT NAVY EXCHANGE SERVICE (NES) STATION, NAS MEMPHIS, MILLINGTON, TN, FACILITY #9-791718

Dear Mr Langreck:

In our letter of 20 August 1991 we recommended ground water monitoring only and a limited risk assessment. As a follow up action, we have contracted with the United States Geologic Survey (USGS) to investigate if the natural biodegration process is sufficient to remediate the gasoline contamination at this site. We are sending you a copy, enclosure (1), of the USGS proposal for your review.

The information obtained during this investigation may defend the monitoring only recommendation or to design a workable bioremediation system.

Your comments and concurrence with this approach is solicited.

If you have any questions, please contact Mr. John Karlyk at (803) 743-0624.

Sincerely,

H. FRASER, P.E.
Head, Petroleum Branch

A-4
Aquifer Tests

Following development of the wells slug tests were performed. To obtain rapid water level readings an electric water meter was used to monitor water level changes. The slug tests were conducted as follows:

- o Measure initial water level.
- o Inject 5 gallons of water down well.
- o Record the corresponding water level drop with respect to time until the water level recovers to within 80 percent of its initial level.

Based on the water level measurements obtained, the hydraulic gradient of the water table surface is estimated to be .0163 feet/foot. Using data from the slug tests in well Nos. 1, 4, and 5, the average hydraulic conductivity is estimated to be 7.69 gpd/ft^2 (1.19×10^{-5} ft/sec). The average hydraulic conductivity, we feel, represents a conservative value based on the interpretation of the field data obtained from the aquifer (slug) tests. The maximum effective porosity was estimated to be 30 percent based on soil classification. Using these figures, particle velocity was estimated as follows:

$$\text{Estimated Velocity} = \frac{(\text{Hydraulic Conductivity})\ (\text{Hydraulic Gradient})}{\text{Effective Porosity}}$$

$$\frac{(1.19 \times 10^{-5}\,\text{feet/sec})\ (.0163\ \text{ft/ft})}{0.30}$$

$$6.5 \times 10^{-7}\ \text{ft/sec or 20 ft/yr}$$

ENCLOSURE (1a)

APPENDIX G

COMPLETE AQUIFER TEST DATA

SLUG TEST MEM-757-1

NAS MEMPHIS
Harding Lawson Associates
January 10, 1987

Elapsed Time (minutes)	Depth to Water (feet)	Drawdown (feet)
0.15	4.20	2.62
0.33	4.31	2.51
0.48	4.42	2.40
0.82	4.63	2.19
1.00	4.75	2.07
1.25	4.85	1.97
1.50	4.95	1.87
2.00	5.10	1.72
2.50	5.23	1.59
3.00	5.32	1.50
3.50	5.37	1.45
4.25	5.50	1.32
5.00	5.54	1.28
6.00	5.65	1.17
7.00	5.63	1.19
8.00	5.68	1.14
9.00	5.73	1.09
10.0	5.80	1.02
12.0	5.84	0.98
14.0	6.05	0.77

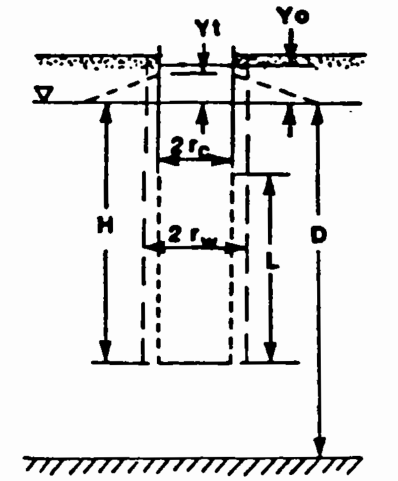
for Unconfined Aquifers with completely of partially penetrating wells.

Harding Lawson Associates
Engineers, Geologists
& Geophysicists

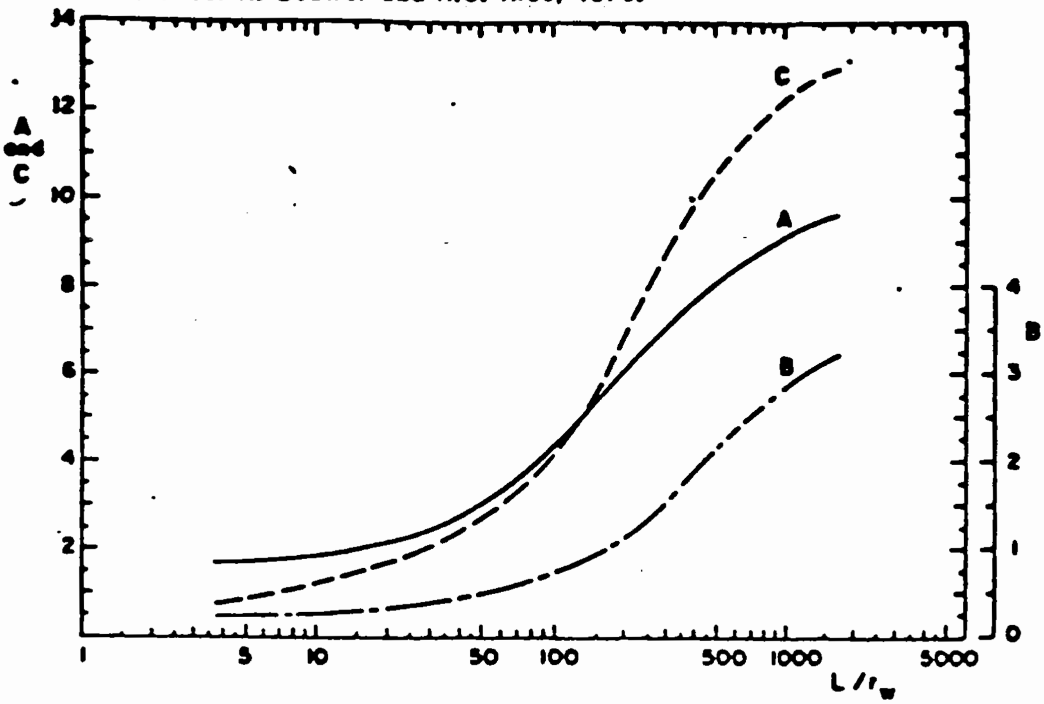
SHEET 2 OF 3
JOB NO. 2176,110.12
DATE 1/19/87
COMPUTED BY CIPM
CHECKED BY HJL

PROJECT NAS Memphis
SUBJECT Slug Test MEM-757-1 1/10/87

Reference: H. Bouwer and R.C. Rice, 1976.



Partially penetrating, partially perforated well in unconfined aquifer.



Curves relating coefficients A, B, and C to L/r_w

D = 13.5'
L = 13.5'
H = 13.5'
r_w = 0.281'
r_c = 0.167'
Yo: 2.77'

L/rw = 48.04; A = 2.98; B = 0.50; C = 2.68

$\ln\{(D-H)/r_w\}$ = 6.0 (max 6.0); if D=H, see*

$$\ln(R_e/r_w) = \left\{\frac{1.1}{\ln(H/r_w)} + \frac{A+B \times \ln\{(D-H)/r_w\}}{L/r_w}\right\}^{-1} = 2.45$$

$$^*\ln(R_e/r_w) = \left\{\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}\right\}^{-1} = 2.94$$

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \cdot \frac{1}{t}\ln(Y_o/Y_t) = \_\_\_\_ \cdot \frac{1}{t}\ln(Yo/Yt)$$

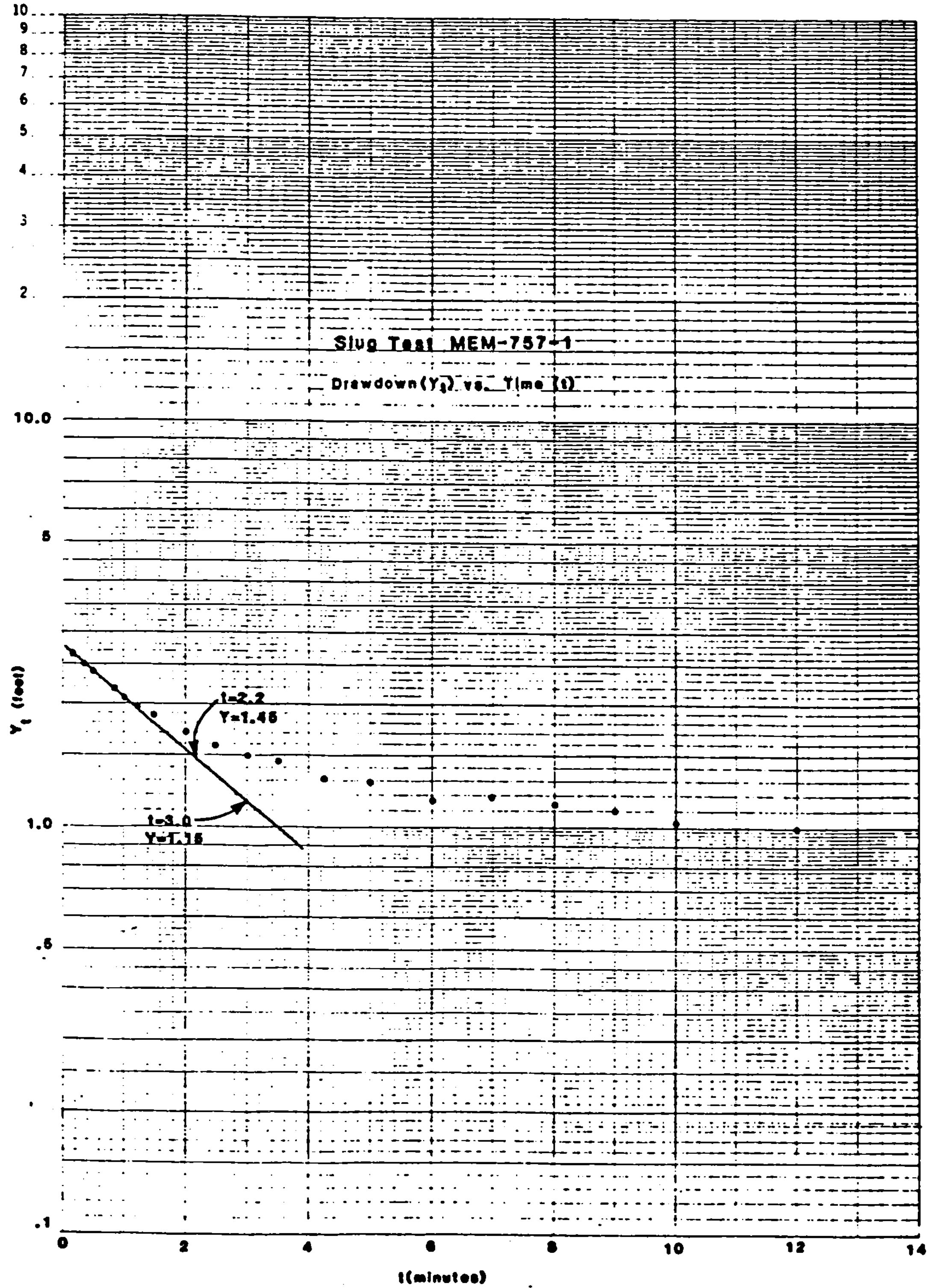
Assumptions: D = H

t (sec)	Y_t (feet)	$\frac{1}{t}\ln(Yo/Yt)$	Hydraulic Conductivity (1) ft/sec	ft/yr	gpd/ft²	Transmissivity ft²/sec
132	1.45	4.90×10^{-3}	1.49×10^{-5}	470	9.63	2.01×10^{-4}
180	1.15	4.88×10^{-3}	1.47×10^{-5}	468	9.59	2.00×10^{-4}

(1) Multiply ft/sec by 646.272 for gpd/ft²

see graph for t and Yt.

1



Harding Lawson Associates
Engineers, Geologists & Geophysicists

SLUG TEST MEM-757-1
NAS Memphis
Millington, Tennessee

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
EL	2176,111.12	ABZ	3/13/87		

SLUG TEST MEM-757-4

NAS MEMPHIS
Harding Lawson Associates
January 10, 1987

Elapsed Time (minutes)	Depth to Water (feet)	Drawdown (feet)
0.00	0.33	4.70
0.30	0.80	4.23
0.37	0.90	4.13
0.42	0.95	4.08
0.50	1.05	3.98
0.75	1.33	3.70
1.00	1.58	3.45
1.50	2.00	3.03
2.00	2.38	2.65
2.50	2.68	2.35
3.00	2.93	2.10
3.50	3.19	1.84
4.00	3.41	1.62
4.50	3.60	1.43
5.00	3.76	1.27
6.00	4.03	1.00
7.00	4.23	0.80
8.00	4.38	0.65

SLUG TEST (Injection)

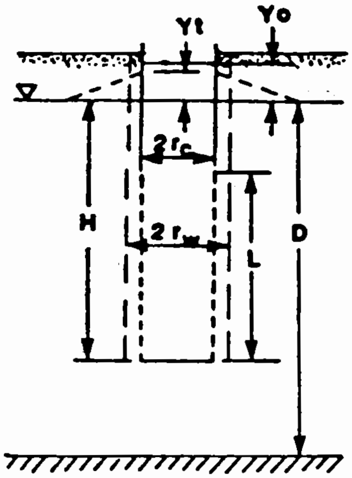
for Unconfined Aquifers with completely or partially penetrating wells.

Harding Lawson Associates
Engineers, Geologists
& Geophysicists

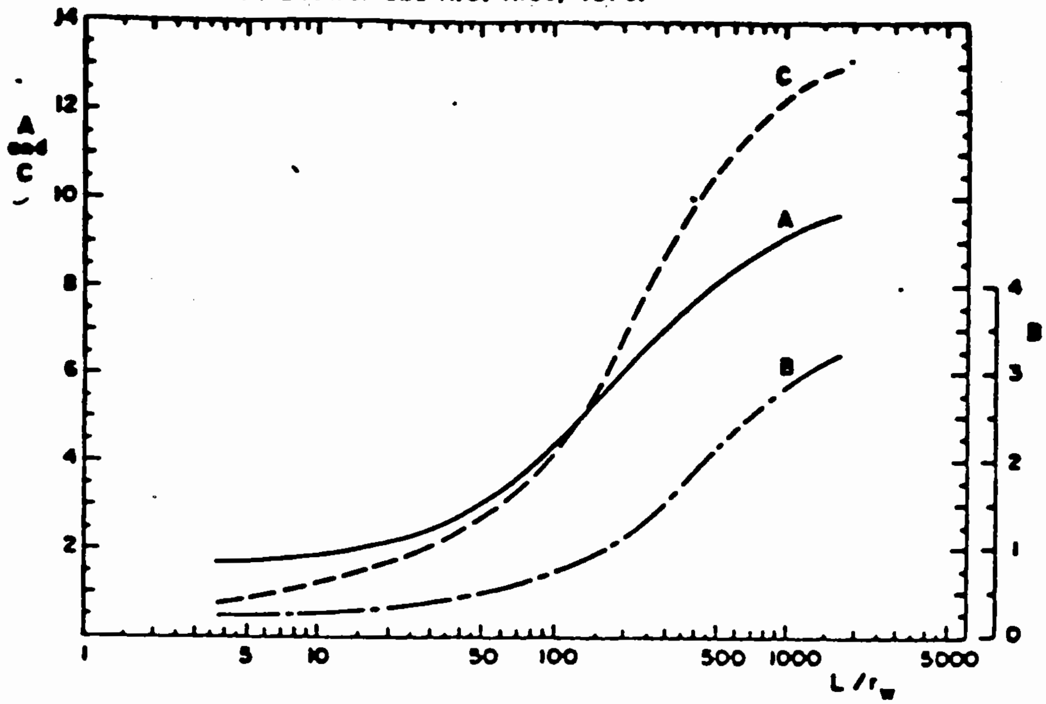
SHEET 2 OF 3
JOB NO. 2176,110.12
DATE 1/19/87
COMPUTED BY CIPM
CHECKED BY HJL

PROJECT NAS Memphis
SUBJECT Slug Test MEM-757-4 1/10/87

Reference: H. Bouwer and R.C. Rice, 1976.



Partially penetrating, partially perforated well in unconfined aquifer.



Curves relating coefficients A, B, and C to L/r_w

D = 14.3'
L = 14.3'
H = 14.3'
r_w = 0.281'
r_c = 0.167'
Yo = 4.70'

L/r_w = 50.89 ; A = 3.10 ; B = 0.51 ; C = 2.75

$\ln\{(D-H)/r_w\}$ = 6.0 (max 6.0); if D=H, see*

$$\ln(R_e/r_w) = \left\{\frac{1.1}{\ln(H/r_w)} + \frac{A+B \times \ln\{(D-H)/r_w\}}{L/r_w}\right\}^{-1} = 2.49$$

$$^*\ln(R_e/r_w) = \left\{\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}\right\}^{-1} = 2.99$$

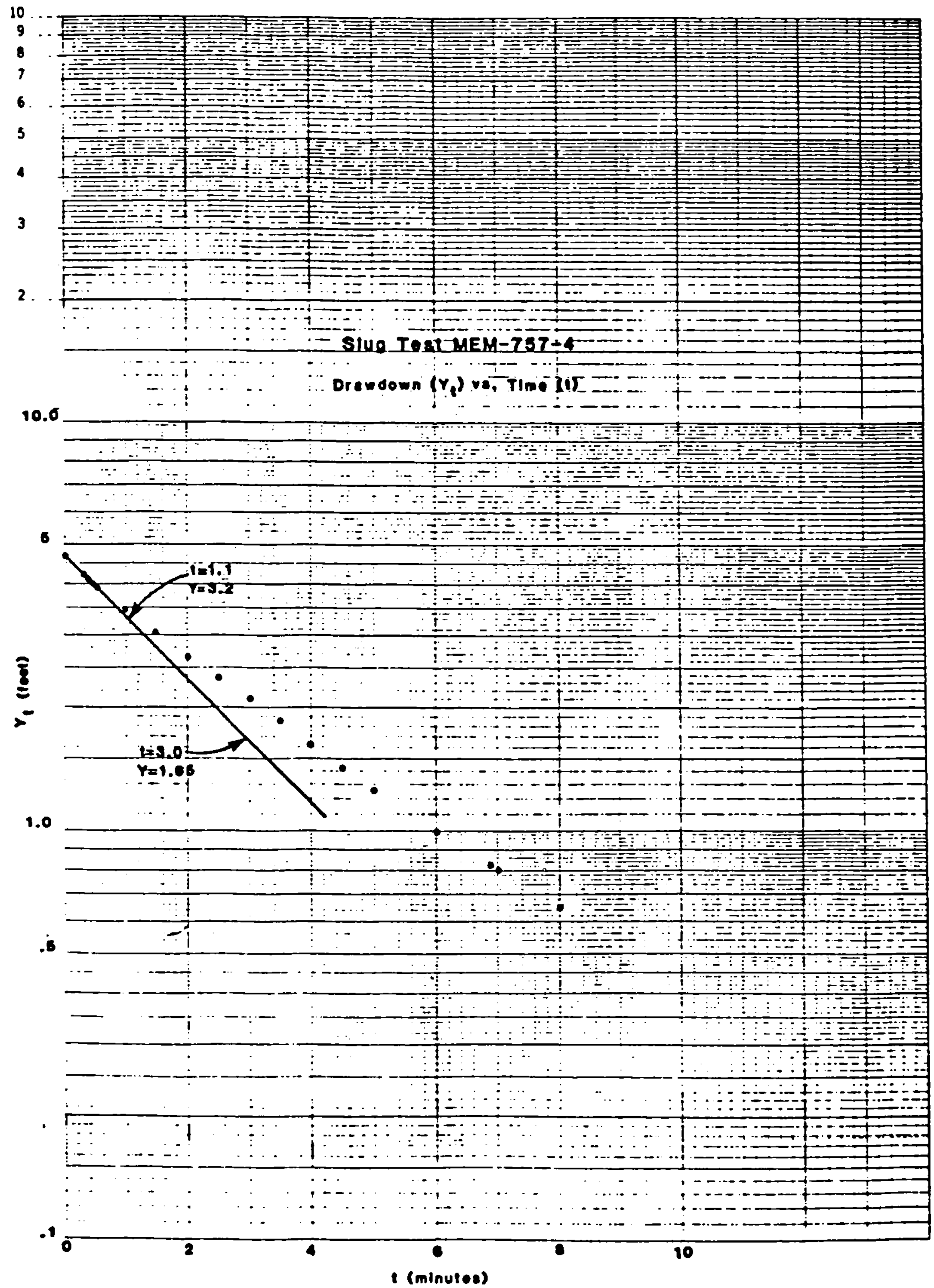
$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \cdot \frac{1}{t}\ln(Y_o/Y_t) = \_\_\_\_ \cdot \frac{1}{t}\ln(Yo/Yt)$$

Assumptions: D = H

t (sec)	Yt (feet)	$\frac{1}{t}\ln(Yo/Yt)$	Hydraulic Conductivity (1) ft/sec	ft/yr	gpd/ft²	Transmissivity ft²/sec
66	3.20	5.82×10^{-3}	1.70×10^{-5}	536	10.98	2.43×10^{-4}
180	1.65	5.82×10^{-3}	1.70×10^{-5}	536	10.98	2.43×10^{-4}

(1) Multiply ft/sec by 646.272 for gpd/ft²

see graph for t and Yt.



Harding Lawson Associates
Engineers Geologists
& Geophysicists

SLUG TEST MEM-757-4

NAS Memphis
Millington, Tennessee

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
ES	2176,111.12	HBL	3/17/87		

SLUG TEST MEM-757-5

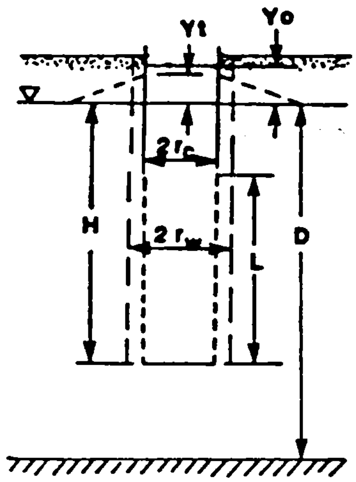
NAS MEMPHIS
Harding Lawson Associates
January 10, 1987

Elapsed Time (minutes)	Depth to Water (feet)	Drawdown (feet)
0.00	1.00	5.36
0.12	1.60	4.76
0.23	1.62	4.74
0.50	1.64	4.72
1.00	1.68	4.68
1.50	1.75	4.61
2.00	1.81	4.55
2.50	1.89	4.47
3.50	2.05	4.31
4.50	2.22	4.14
5.50	2.37	3.99
7.00	2.55	3.81
8.00	2.68	3.68
9.00	2.80	3.56
10.00	2.90	3.46
12.00	3.09	3.27
14.00	3.28	3.08
16.00	3.43	2.92
18.00	3.58	2.78
20.00	3.69	2.67
25.00	3.98	2.38
30.00	4.20	2.16
34.00	4.35	2.01

for Unconfined Aquifers with completely or partially penetrating wells.

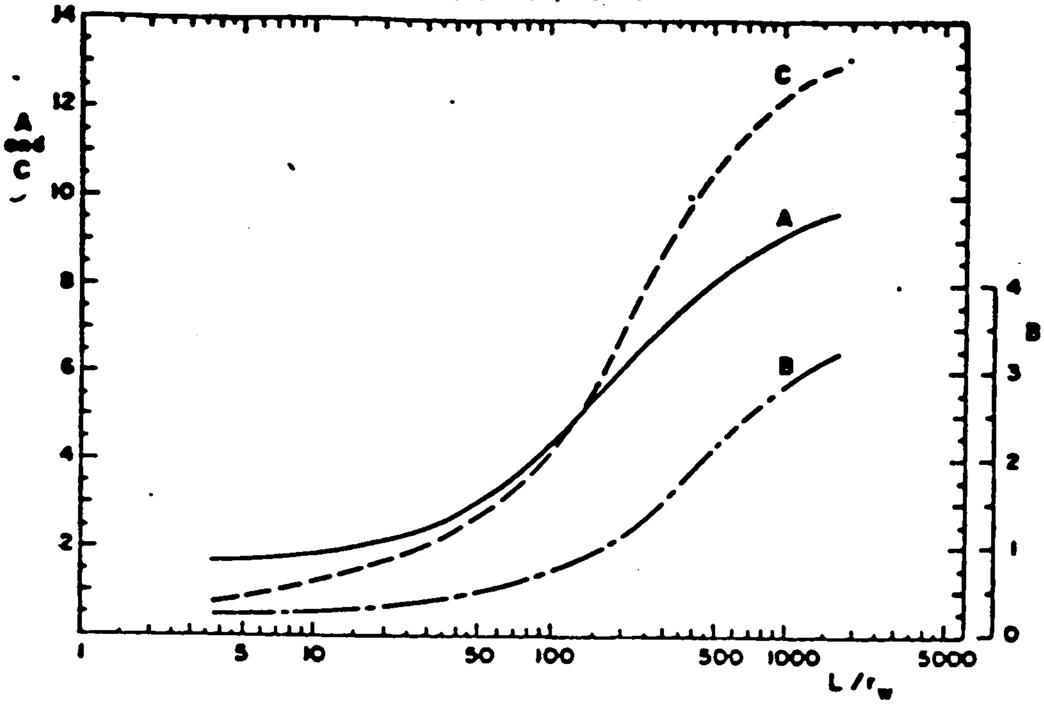
Harding Lawson Associates
Engineers, Geologists
& Geophysicists

SHEET 2 OF 3
JOB NO. 2176,110.12
DATE 1/10/87
PROJECT NAS Memphis
COMPUTED BY CIPM
SUBJECT Slug Test MEM-757-5 1/10/87
CHECKED BY HJL



Partially penetrating, partially perforated well in unconfined aquifer.

Reference: H. Bouwer and R.C. Rice, 1976.



Curves relating coefficients A, B, and C to L/rw

D = 13.4'
L = 13.4'
H = 13.4'
r_w = 0.281'
r_c = 0.167'
Yo = 5.36'

L/rw = 47.69 ; A = 3.00 ; B = 0.49 ; C = 2.62

$\ln\{(D-H)/r_w\}$ = ____ (max 6.0); if D=H, see*

$$\ln(R_e/r_w) = \left\{\frac{1.1}{\ln(H/r_w)} + \frac{A+B \times \ln\{(D-H)/r_w\}}{L/r_w}\right\}^{-1} = 2.44$$

$${}^{*}\ln(R_e/r_w) = \left\{\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}\right\}^{-1} = 2.95$$

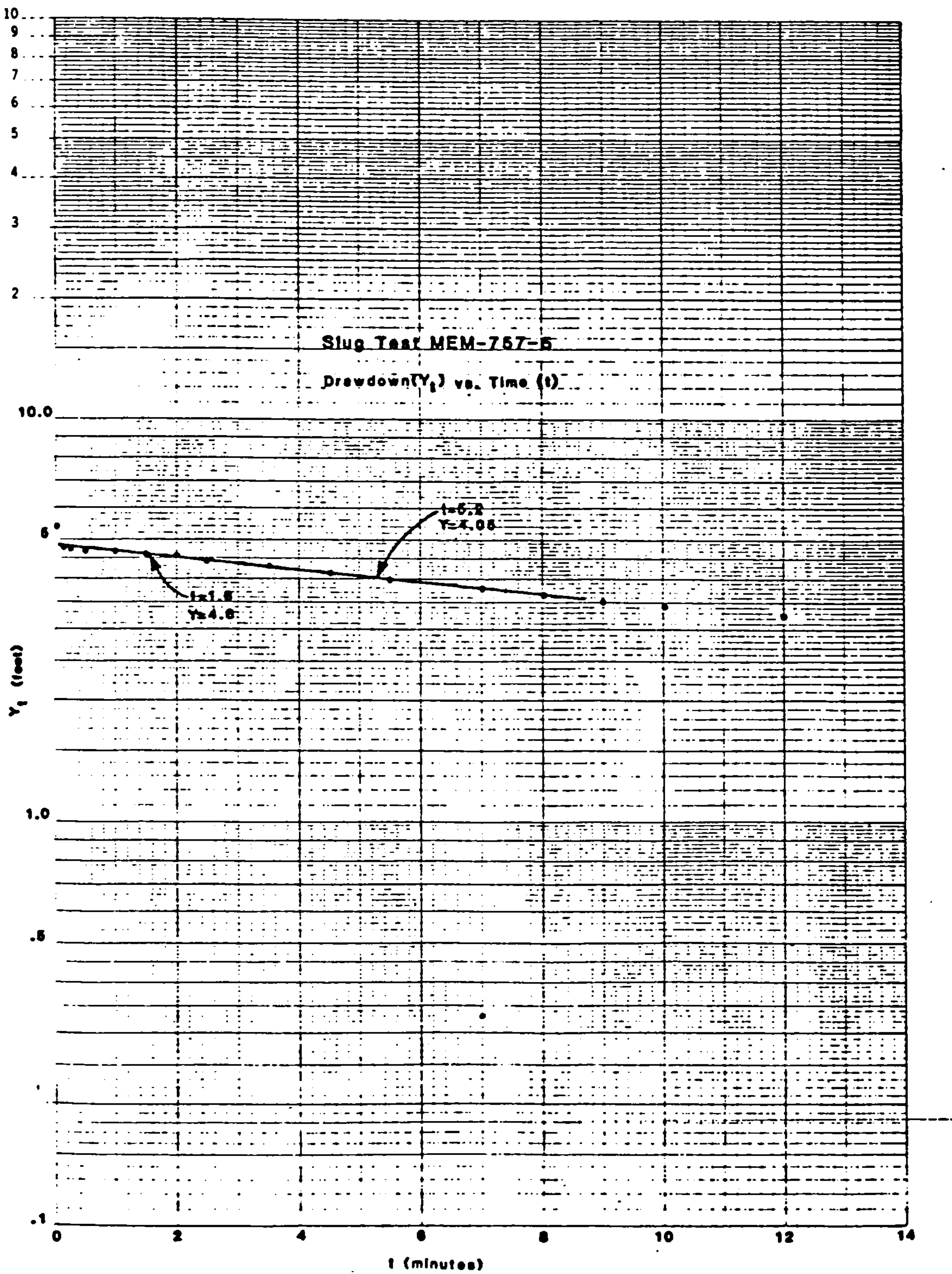
$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \cdot \frac{1}{t}\ln(Y_o/Y_t) = \_\_\_\_ * \frac{1}{t}\ln(Yo/Yt)$$

Assumptions: D = H

t	Y_t	$\frac{1}{t}\ln(Yo/Yt)$	Hydraulic Conductivity (1) ft/sec	ft/yr	gpd/ft²	Transmissivity ft²/sec
96	4.60	1.59×10^{-3}	4.80×10^{-6}	154	3.15	6.54×10^{-5}
312	4.05	8.98×10^{-4}	2.76×10^{-6}	87	1.78	3.69×10^{-5}

(1) Multiply ft/sec by 646.272 for gpd/ft²

see graph for t and Yt.



Harding Lawson Associates
Engineers Geologists
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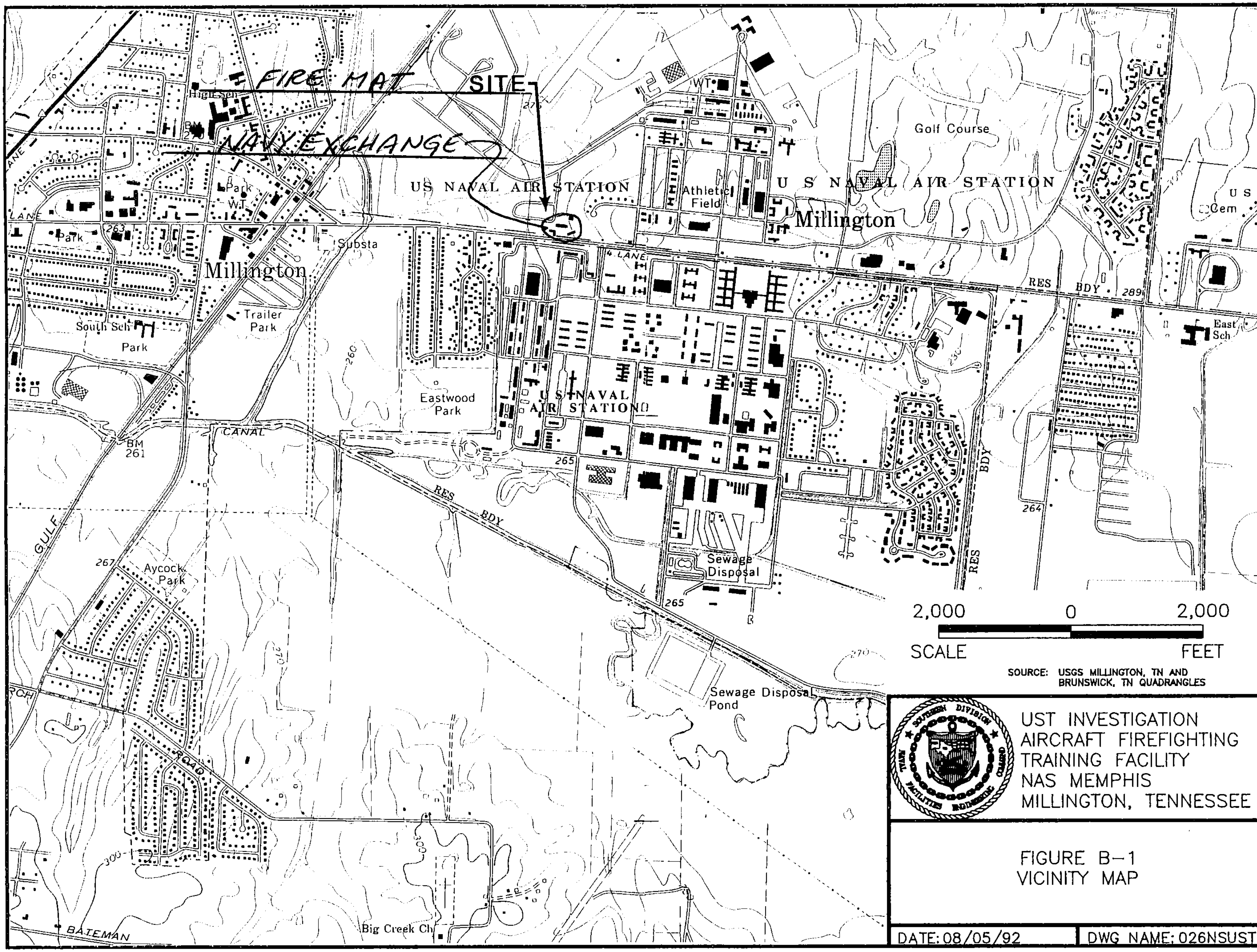
SLUG TEST MEM-757-5

NAS Memphis
Millington, Tennessee

PLATE

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
ES	2176,111.12	NBL	3/13/87		



UST INVESTIGATION
AIRCRAFT FIREFIGHTING
TRAINING FACILITY
NAS MEMPHIS
MILLINGTON, TENNESSEE

FIGURE B-1
VICINITY MAP

DATE: 08/05/92 | DWG NAME: 026NSUST

ENCLOSURE (2)

C.8 Groundwater Classification Procedure

The Tennessee State UST Guidelines set forth requirements to determine if the impacted aquifer is a drinking water source or a non-drinking water source. The cleanup level is directly dependent on classification of the aquifer use. This process consists of three parts including: (1) water use survey, (2) water quality analysis, and (3) yield testing. Each step is completed in sequence until the results of one step show that the aquifer is not suitable as a drinking water source.

The steps completed in this investigation are discussed below.

Water Use Survey:

A water well search conducted by the Memphis and Shelby County Health Department does not indicate any use of shallow groundwater for the purposes of domestic or agricultural use within one mile of the site (Sherrill, 8/06/92). Active public water supply wells in the area tap deeper aquifers hydraulically separated from upper groundwater by the clays of the Jackson Upper Claiborne Confining Unit (E/A&H 1992). The nearest wells include two Navy base supply wells 2700 ft. northeast and 1600 ft. southeast of the site drawing from the Memphis Sand and Fort Pillow Formation, respectively, and a Millington supply well 3800 ft. due west of the site tapping the Memphis Sand (E/A&H 1992). Between 34 to 108 ft. of clays of the Jackson Upper Claiborne Confining Unit separate these deep aquifers from shallow groundwater throughout the area (Parks 1990).

Analytical Results for Drinking Water Standards:

Groundwater samples to be analyzed for Primary and Secondary Drinking Water Standards were taken from the representative background well MW-05 on July 27, 1992, and sent to Specialized Assays in Nashville, Tennessee, for analysis. Results are presented in Table C-11. The analyses reveal that the shallow groundwater beneath the site exceeds the drinking water standards for detergents, iron, manganese and turbidity. Thus the viability of use as a potential water supply resource is negated.

Groundwater Clean-up Levels:

Based upon the collected water use and analytical data, the shallow groundwater in the vicinity of the site is a "non-drinking water supply." TDEC-UST regulations indicate that for any UST-derived petroleum groundwater contamination in an aquifer unsuitable for drinking water supply, groundwater clean-up levels are 0.070 ppm benzene and 1.000 ppm TPH.

Table C-11
Groundwater Analytical Results
Primary and Secondary Drinking Water Standards
MW-05 (07/27/92)

Parameter	Result	Standard	Units
PRIMARY STANDARDS			
Arsenic	0.007	0.05	PPM
Barium	0.75	1.0	PPM
Cadmium	<0.001	0.01	PPM
Chromium, Total	0.050	0.05	PPM
Fluoride, Electrode	0.33	4.0	PPM
Lead	0.028	0.05	PPM
Mercury	<0.001	0.002	PPM
Nitrogen, Nitrate	<0.10	10.0	PPM
Selenium	<0.005	0.01	PPM
Silver	<0.005	0.05	PPM
SECONDARY STANDARDS			
Total Hardness	318	—	MG/L CACO3
Chloride	5.3	250	PPM
Color	5	15	PT-CO Units
Copper	0.12	1.0	PPM
Detergents (MBAS)	0.22*	0.05	PPM
Iron	70.8*	0.03	PPM
Manganese	2.09*	0.05	PPM
Odor	0	3	T.O.N. UNIT
pH	6.8	6.5 - 8.5	PPM
Sodium	15.0	—	PPM
Sulfate	18	250	PPM
Solids, Dissolved	403	500	PPM
Zinc	0.31	5.0	PPM
Turbidity	6.6*	1.0	N.T. UNITS

NOTE:
* Exceeds Drinking Water Standards